

A CONTRIBUTION TO THE ECOLOGY OF CATHCART AND ENVIRONS WITH SPECIAL REFERENCE TO SLOPE EXPOSURE AND SOIL pH.

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(With Plates XXVI to XXVIII)

ABSTRACT

The vegetation of three distinct veldtypes in different climatic regions of the Cathcart district is described in relation to environmental conditions and affinities to tropical and temperate floras. The localities investigated are the Black Kei river valley (alt. 2,800', rain 435 mm.), Windvoëlberg (alt. 5,350', rain 645 mm.) and Gaikaskop (alt. 6,300', rain 1,064 mm.).

Plant lists are given of the most important species in each of the three localities, with special reference to the *Gramineae*. In the case of Windvoëlberg the meso- and xerocline communities are considered separately and differences in physiognomy and dominants are emphasised. The relationships between these communities and the semi-arid Kei valley savannah and the humid *Podocarpus* forest of the Amatole range is considered. Special reference is made to the distribution of the primitive *Encephalartos cycadifolius*.

Preliminary investigations into the pH and total salt concentration of the soil of opposing slopes indicate that there is no correlation between these factors and the distribution of the dominant species. The importance of slope exposure, primarily due to its influence on sunlight intensity and the resultant evaporation and soil moisture, is discussed in the light of relevant literature.

INTRODUCTION

The portion of the Amatole mountain range known as Windvoëlberg, which overlooks the village of Cathcart in the Cape Province, displays an unusual mixture of vegetation types and provides a striking example of the effect of slope exposure on the vegetation. This mountain rises to a height of 1,850 feet above the grassveld plains and is situated approximately midway between the hot dry valley of the Black Kei river and the more temperate high rainfall area of the Amatole range known as the Hogsback. (See accompanying map.) The change in climate and altitude within a distance of approximately 35 miles is accompanied by a significant change in vegetation which has an important influence on pastoral practices in that district.

The writer has had the opportunity of tracing the variations in vegetation from the two extreme types, in the Kei valley and at Gaikaskop respectively, to where the so-called sourveld (humid) and the sweetveld (semi-arid) meet. One such transitional area is a deep ravine in Windvoëlberg, which provides what must be one of the most striking examples of slope exposure in South Africa.

Specimens of the most important grasses and woody plants were collected on north-facing slopes in all three of the above-mentioned localities and at Windvoëlberg north- and south-facing slopes were compared floristically. Soil samples from opposing slopes were investigated for pH and total salt values at the latter locality.

PHYSICAL FEATURES

The area concerned falls within the region of South Africa which is underlain by the geologic group known as the Karoo system. The Amatole range is made up almost entirely of dolorite although sandstone of the Beaufort series is found to a limited extent in the lower lying areas. The vegetation of the localities investigated on Gaikaskop and Windvoëlberg occur on dolorite (ironstone) while the sampling areas on the banks of the Black Kei river are underlain by sandstone. The sampling areas at the Black Kei river which were used in this investigation occur at an altitude of 2,800 feet above sea level, on the farm Grey Craig. The summits of Gaikaskop and Windvoëlberg are 6,300 feet and 5,349 feet respectively. The accompanying map indicates the undulating nature of the district and the gradual decrease in altitude from Gaikaskop to the Black Kei river.

CLIMATE

The Gaikaskop area receives an annual rainfall of 1,064 mm. (Weather Bureau, 1950). According to Story (1952) who carried out a comprehensive plant ecological survey of the Keiskammahoek area of the Amatoles, 30 per cent of the rain which this area receives, falls during the winter. The nearby Hogsback forest station has an average of 105 rainy days per annum (Story, 1952). The large number of cloudy days and the frequent occurrence of thick mist in the Gaikaskop area result in considerably more mesophytic habitat conditions than the rainfall figure might indicate. In Table I the rainfall normals for stations occurring in the localities under consideration are given. Wolfridge is four miles south of Gaikaskop, Exwell Park is six miles from the Black Kei and the Cathcart forest station is on the Windvoëlberg.

TABLE I

Rainfall normals for the Cathcart area (Weather Bureau, 1950).

Station No.	Station	Lat.	Longt.	Alt.	Period Yrs.	Max. mm.	Min. mm.	Av. mm.
78/879	Wolfridge	32° 39'	27° 00'	4000'	52	1509	615	1064
101/192	Exwell Park . . .	32° 12'	27° 07'	2900'	50	637	228	435
101/228	Cathcart Mountain Forest	32° 18'	27° 08'	3900'	45	879	320	645



FIG. 1. Map of Cathcart and Environs.

Temperature data for the area are incomplete since no readings are available for the Kei valley. The Gaikaskop locality enjoys a considerably cooler summer than is experienced in the Kei valley. At the former locality, January is the hottest month, with a mean daily maximum temperature of 71·9°F and an absolute maximum of 91·0°F. August is the coldest month with a mean daily minimum of 39·6°F and an absolute minimum of 28·0°F. The diurnal air temperature range is approximately 15° in winter and 21° in summer. This range is considerably less on mountain peaks such as Gaikaskop than in the valleys. Maxima in the lowlands are 15° higher than in the mountains on the average (Story, 1952). The winters are cold and windy with severe frost and snow as normal phenomena. Temperature inversion is an important ecological consideration in this locality.

As regards the Windvoëlberg locality, temperatures for Cathcart may be summarised as shown in Table II.

TABLE II

Temperatures (°C) for Cathcart (Goal, 1906–1950) (Weather Bureau, 1954).

Month	Mean of Daily Max.	Extreme Daily Max.	Mean of Daily Min.	Extreme Daily Min.	Range (Max.– Min.)
January	26·5	38·3	12·0	2·2	14·5
February	25·8	38·1	12·7	1·1	13·1
March	24·6	36·1	11·9	2·8	12·7
April	21·9	37·1	9·1	–1·1	12·8
May	18·8	30·6	6·4	–2·3	12·4
June	16·2	24·9	4·4	–4·4	11·8
July	15·8	26·0	4·3	–4·1	11·5
August	18·2	30·0	5·1	–5·2	13·1
September	20·5	33·3	6·3	–3·3	14·2
October	22·3	37·2	8·3	–2·8	14·0
November	23·8	36·1	9·3	0·6	14·5
December	25·3	37·9	11·2	2·8	14·1

The Kei valley is considerably hotter than the higher lying locality at the village of Cathcart, due presumably to the lower elevation and concave physical features in the former case.

THE VEGETATION

(i) *The Black Kei River Valley*

The semi-arid savannah of the valley is characterised by the dominance of *Acacia karoo* which causes encroachment problems on most farms in the valley. The most xerophytic communities of the valley are found on the steep north-facing stony slopes overlooking the river. Intense insolation, high evaporation

and runoff combine to form a habitat which is considerably more xeric than is the case at other sites in the valley.

The following grasses were recorded from the sampling area selected at site A on the accompanying map:

Setaria lindenbergiana, *Panicum maximum*, *Rhynchelytrum repens*, *Cenchrus ciliaris*, *Enneapogon scoparius*, *Bothriochloa radicans*, *Cynodon incompletus*, *Aristida barbicollis*, *Eragrostis curvula*;

Of the woody plants occurring at this site the most important are:

Acacia karoo, *Aloe ferox*, *Crassula portulacea*, *Grewia occidentalis*, *Euclea crispa*, *Euryops spathaceus*, *Ehretia rigida*, *Kalanchoe rotundifolia*, *Combretum erythrophyllum*, *Celtis africana*, *Zizyphus zeyheriana*.

Site A at which the above plants were collected is a steep krantz-like rock face of sandstone, typical of the habitats which overlook the Kei river in this district. (See Plate XXVI.)

(ii) *Gaikaskop*

Gaikaskop is a striking solitary dome-shaped mountain (site B on map) which supports a dense grassveld with trees virtually absent except in a number of small screes where stunted trees are common.

The grassveld is a short sourveld in which the following grasses were recorded:

Agrostis barbuligera, *Agrostis lacnantha*, *Aristida galpinii*, *Bromus speciosus*, *Cymbopogon validus*, *Danthonia drakensbergensis*, *Danthonia macowanii*, *Ehrharta calycina*, *Eragrostis capensis*, *Eragrostis curvula*, *Eragrostis racemosa*, *Elyonurus argenteus*, *Festuca caprina*, *Festuca caprina* var. *irrasa*, *Harpechloa falx*, *Helictotrichon hirtulum*, *Heteropogon contortus*, *Koeleria cristata*, *Lasiochloa longifera*, *Microchloa caffra*, *Pentaschistis thunbergii*, *Pentaschistis tysonii*, *Pentaschistis* sp., *Setaria flabellata*, *Themeda triandra*, *Trachypogon capensis*, *Tristachya hispida*, *Vulpia bromoides*, *Vulpia myuros*.

As may be deduced from the above list, the grassveld has both tropical and temperate affinities. The temperate genera *Danthonia*, *Ehrharta*, *Festuca*, *Lasiochloa* and *Pentaschistis* occur mainly near the summit and are characteristic of cool moist mountain tops in this region. The temperate affinity of the flora is also indicated by the abundance of sclerophyllous species such as the following which were collected above 5,500 feet:

Aster filifolius, *Arrowsmithia styphelioides*, *Cliffortia eriocephalina*, *Erica leucopelta*, *Erica caffrorum*, *Passerina montana*, *Phyllica* sp. (cf. *P. galpinii* Pillans), *Restio* sp., *Stoebe vulgaris*.

These representatives of the macchia or fynbos flora only occur to any appreciable extent in this area in rocky high altitude environments and only reach full development when protected from fire for several seasons.

PLATE XXVI. Black Kei river valley (*Aloe ferox*, *Acacia karoo*, *Ehretia rigida*, *Cenchrus ciliaris*, *Kalanchoe rotundifolia*).







PLATE XXVIII. *Festuca* tussock grassveld on mesocline of Windvoëlberg.

The most important bushes and herbs collected on Gaikaskop are:

Asparagus microraphis, *Diascia rigescens*, *Geranium ornithopodum*, *Hebenstreitita* sp. (cf. *H. dentata*), *Helichrysum epapposum*, *Helichrysum fulgidum*, *Helichrysum splendidum* var. *montanum*, *Indigofera cuneifolia*, *Myrsine africana*, *Stachys aethiopica*.

With the exception of *Protea lacticolor* which appears not to be injured to any extent by fire, all the larger shrubs or trees occur in rocky screes or between boulders where they are protected from fire. *Kiggelaria africana* is the only tree of any size which is found on Gaikaskop. It grows to a height of 15—20 feet in this environment. Other woody species such as *Rhus pyroides* and *Buddleia salviifolia*, which grow into trees of considerable size in more favourable environments in South Africa, develop into stunted and often gnarled shrubs on Gaikaskop.

Arundinaria tessellata is a plant of special interest which was collected on the summit of Gaikaskop. This unusual plant, known locally as "Mountain Bamboo" or "*Rottangboom*", is unique in form amongst South African plants. It is also the largest South African member of the grass family known to the writer. Its culms reach a diameter of one inch at the base and a height of eight feet. Since the plant usually forms a dense thicket, up to a few yards in diameter, the basal leaves are lost and each culm generally only bears a brush of leaves on the topmost nodes. The leaves are short, broad and leathery and are apparently well adapted to the high winds which prevail in such sites.

Arundinaria tessellata has been collected by the writer only in moist high altitude habitats, and always in rock crevices on the summits of high mountains (Elandsberg (6,624 feet) and Hogsback (6,360 feet) of the Amatole range, Rensburgskop (7,300 feet) in the Harrismith district and Aasvoëlberg (7,250 feet) in the Zastron district).

The habitat conditions prevailing in the screes are undoubtedly moist for the greater part of the year as may be judged from the abundance of such moisture-loving genera as *Rubus*, *Agapanthus*, *Kniphofia* and *Zantedeschia*. High atmospheric moisture is indicated by the growth of *Usnea* ("Spanish Moss" or "Old Man's Beard") on the larger trees in the screes.

Although Gaikaskop was not investigated by Story (1952), the reader is referred to Story's comprehensive survey of the vegetation of the nearby Amatole mountains.

(iii) *Windvoëlberg*

The vegetation of Windvoëlberg displays several different associations whose floristic composition vary with aspect, slope, soil depth and altitude.

This investigation considers the vegetation of the north and south slopes of the deep ravine known locally as "the Kloof". Specimens were collected at

various sampling sites (at C on map) from the stream banks in the lowest portion of the ravine to the summits of the dolorite ridges on either side. The species listed below therefore represent a vertical cross section of the vegetation of the ravine.

(a) *Xerocline*. The north-facing slope is a rocky mountainside with a gradient of approximately 30°. The slope is strewn with dolorite boulders and the vegetation is characterised by the abundance of *Aloe ferox*, *Olea africana*, *Euclea crispa* and *Hyparrhenia hirta*. The abundance of *Aloe ferox* is typical of north and north-western slopes in the drier sweetveld areas of this region and this plant is generally regarded as an indicator of sweet grassveld in these areas.

Plate XXVII gives some indication of the physiognomy of the xerocline and the importance of the species mentioned above.

The majority of grasses which were collected on the xerocline are typical of hillside grassveld in many mixed grassveld areas of South Africa, namely:

Brachiaria serrata, *Cymbopogon excavatus*, *Cynodon dactylon*, *Eragrostis chloramelas*, *Hyparrhenia hirta*, *Rhynchelytrum setifolium*, *Themeda triandra*.

These species are often indicative of hot semi-arid conditions and are found to be typical components of hillside grassveld in many districts of the Orange Free State which receive between 15 and 20 inches of rain per annum. However, the upper reaches of the xerocline include several sourveld grasses with somewhat higher moisture requirements than the mixedveld species listed above, namely:

Digitaria diagonalis, *Eragrostis capensis*, *Tristachya hispida*, *Sporobolus indicus*.

The stoloniferous *Digitaria pentzii* is a valuable grazing grass and is particularly useful in binding the soil on steep slopes.

The following non-grasses are of general occurrence on the northern slopes in association with the above grasses:

Acokanthera oppositifolia, *Carissa bispinosa* var. *acuminata*, *Cassia* sp. nov. (Roberts No. 1728), *Clematis oweniae*, *Clutia pulchella*, *Colpoos compressum*, *Crassula portulacea*, *Crassula* sp., *Cussonia spicata*, *Cussonia paniculata*, *Diospyros scabrida* var. *cordata*, *Encephalartos cycadifolius*, *Euclea crispa* var. *crispa*, *Grewia* sp. (cf. *G. occidentalis*), *Helichrysum rugulosum*, *Hippobromus* sp., *Indigofera* sp., *Kalanchoe paniculata*, *Leonotis dubium*, *Maytenus cymosus*, *Myrsine africana*, *Olea africana*, *Plectranthus grandidentatus*, *Pterocelastrus tricuspidatus*, *Rhoicissus tridentata*, *Rhus dentata*, *Rhus lucida*, *Schistostephium crataegifolium*, *Scolopia mundii*, *Senecio deltoideus*, *Senecio glaberrimus*, *Solanum tormentosum*, *Venidium microcephalum*, *Vernonia natalensis*.

It is clear that this vegetation is derived to a large degree from the tropical flora, as seen by the abundance of genera such as *Cussonia*, *Diospyros*, *Euclea*, *Grewia*, *Maytenus*, *Olea* and *Rhus*. The mesophytic genera such as *Clusia* and *Myrsine* are limited to moist sites adjacent to large boulders.

The cycad *Encephalartos cycadifolius* is recognised as one of the most primitive types of plant in South Africa and for this reason its abundance on Windvoëlberg is of particular interest. It was first collected on Windvoëlberg by Drege (Pearson, 1905) and it appears from the literature (Anon, 1916) to be limited in distribution to the vicinity of Queenstown, Cathcart and Thomas River. (According to Henderson (1943) *Encephalartos cycadifolius* Lehm. is synonymous with the earlier species name *E. Frederici-Guilielmi* Lehm.) Although it is stated to be "abundant on doloritic hills" (Anon, 1916) in the above-mentioned districts, the present writer has observed *Encephalartos cycadifolius* growing in abundance on sandstone formations in several parts of the Cathcart district.

(b) *Mesocline*. The angle of slope of the south-facing aspect of the ravine varies a great deal but the general steepness is comparable to the northern aspect. The southern aspect is more densely wooded than the northern slope and supports a denser ground layer. The lower portion of the slope is a parkland with a dense grass sward growing between lichen-covered dolorite boulders, separating one copse of mixed evergreen forest from the other. Near the upper limits of the mesocline the vegetation changes to a tall tussock formation of coarse grass with only occasional lichen-covered trees (See Plate XXVIII).

On the lower portion of the mesocline the following grasses are of general occurrence:

Cymbopogon excavatus, *Cymbopogon plurinodis*, *Digitaria diagonalis*, *Eragrostis capensis*, *Eragrostis chloramelas*, *Eragrostis curvula*, *Festuca longipes*, *Helictotrichon turgidulum*, *Koeleria cristata*, *Themeda triandra*, *Tristachya hispida*.

In comparison with the xerocline the absence of *Hyparrhenia hirta* from the mesocline is conspicuous and completely alters the general character of the grassveld. The higher lying tussock community is dominated by *Festuca costata*, with *Cymbopogon validus* abundant. *Ehrharta calycina* and *Pentaschistis* sp. are common in this habitat too but are less noticeable as a result of their being overshadowed by the tall tussocks of *Festuca* and *Cymbopogon*.

Although the general physiognomy of the mesocline is strikingly different from that of the xerocline (compare Plates XXVII and XXVIII), the majority of plants which occur on the xerocline are also found on the mesocline. The most important trees on the mesocline are:

Buddleia salviifolia, *Cussonia paniculata*, *Diospyros scabrida* var. *cordata*,

Euclea crispa var. *crispa*, *Heteromorpha trifoliata*, *Olea africana*, *Pittosporum viridiflorum*, *Rapanea melanophloeos*, *Rhamnus prinoides*, *Rhus lucida*, *Rhus pyroides*.

With the exception of the species of *Diospyros*, *Euclea* and *Olea*, all the above trees have been observed by the writer to be typical components of the moist *Podocarpus* forest in the Hogsback-Katberg region of the Amatole escarpment. Their success as an association on the mesocline of Windvoëlberg indicates the significant influence which slope exposure must exert on the microclimate and especially on soil moisture.

Common shrubs, climbers and herbs collected on the mesocline are:

Asparagus virgatus, *Berkheya carduoides*, *Cineraria lobata*, *Chrysanthemoides monilifera*, *Clematis oweniae*, *Cliffortia serpyllifolia*, *Clutia pulchella*, *Conyza pinnata*, *Crassula vaginata*, *Diascia rigescens*, *Eriocephalus punctulatus*, *Euryops tenuissimus*, *Haplocarpa scaposa*, *Helichrysum adscendens*, *Helichrysum fulgidum*, *Lebeckia* sp., *Melianthus insignis*, *Myrsine africana*, *Pelargonium querifolium*, *Polemannia grossulariaefolia*, *Psoralea caffra*, *Psoralea pinnata*, *Rhoicissus microphylla*, *Rhus dentata*, *Scabiosa columbaria*, *Schistostephium crataegifolium*, *Senecio glaberrimus*, *Senecio* sp., *Stachys aethiopica*.

The growth form of *Clutia* and *Myrsine* on this slope is markedly more robust than on the xerocline.

Although the ground layer requires considerably more investigation before a complete check list of the vegetation may be compiled, the above lists give a good indication of the type of vegetation occurring on Windvoëlberg.

(c) *The relation of soil pH and microclimate to plant distribution.* Although the differences in vegetation of opposed slopes is a common phenomenon, the causes of such differences vary from place to place. Soil acidity is one factor which is frequently quoted as influencing vegetation type. The relation of soil acidity to plant distribution has been investigated by Wherry (1922), Olsen (1923), Kurz (1923), Pearsall (1924) and Salisbury (1925). Attention was first drawn to the ecological significance of soil acidity in South Africa by Bews and Aitken (1922). Both Olsen's field studies and his experiments suggest that the hydrogen ion concentration of the soil determine to a large extent the floristic composition of its plant covering. In the words of Tansley and Chipp (1926), "It has been shown that soil reaction is one of the most important factors determining the distribution of many species and communities of plants." These authors also maintain that stratification of pH leads to surface pH being lower than subsoil pH, which may result in plants of different pH tolerance growing in association.

In the present investigation, replicated samples of top soil (0—9") were taken at representative sites on north- and south-facing slopes and analysed

by the glass electrode method (in water) for pH and by the electrical resistance method for total salts. The results obtained from duplicate analyses of each sample are recorded in Table III:

TABLE III
pH and Total Salt Concentration of Soils from
Windvoëlberg, Cathcart, C.P.

Sample No.	Aspect	pH	Resistance (ohms)
1	North facing	6.00, 6.00	1240, 1240
2	North facing	6.15, 6.15	1180, 1180
3	South facing	6.35, 6.35	1320, 1320
4	South facing	6.10, 6.10	1500, 1500

Although these limited data do not justify definite conclusions, it is noteworthy that, since resistance is inversely related to salt concentration, the mesocline appears to have a lower salt concentration and a somewhat higher pH than are found on the xerocline.

DISCUSSION

The tendency indicated by the pH values above is contrary to the expected results when considered in the light of our knowledge of plant density, runoff and leaching on xero- and mesoclines. The writer has investigated the soil pH in a similar situation on the Thaba'Nchu mountain at an altitude of 7,000' in the south-eastern Orange Free State. In the latter case, the north- and south-facing slopes of a steep dolorite "knife-edge" support strikingly different plant communities and in this case the pH of the topsoil of the xerocline was 7.00 and of the mesocline 6.05, i.e. almost one pH unit difference.

In the absence of significant differences in soil acidity, explanation of the differences in botanical composition of the north- and south-facing slopes of Windvoëlberg may be sought in the differences in microclimate which occur between such exposures. Aitken (1922) has clearly demonstrated the significant differences in microclimate on such slopes in the Midlands of Natal; his results are summarised in Table IV:

TABLE IV
Diurnal Microclimatic Data for a Hill near Pietermaritzburg
(Aitken, 1922).

Factor	North-facing slope	South-facing slope
Sunlight intensity ..	146 mg. iodine/day	107 mg. iodine/day
Evaporation	39 cc. water	22 cc. water
Max. Air Temperature	26.6°C	23.25°C
Max. Soil Temperature	25.2°C at 2"	13.05°C at 2"
Soil Moisture	12.03%	25.43%

It is known that sunlight intensity is the primary factor which results in higher air and soil temperatures, which lead to higher evaporation and the resultant lower soil moisture on northern slopes. Although in Aitken's case sunlight intensity and evaporation were in a ratio of 2 : 3 and 1 : 2 on opposing slopes, soil moisture on the xerocline was less than half that on the mesocline.

Windvoëlberg presents a similar case to the above and there is little doubt that soil moisture studies on Windvoëlberg would indicate similar trends for the above reasons. The principles involved in the determination of physiognomy and floristic composition of opposing slope exposures appear to hold good in the majority of cases in South Africa where the beneficial effect of lower sunlight intensity on soil moisture, results from the direction and angle of slope as described by Roberts (1961) in referring to the Thaba'Nchu area of the Orange Free State.

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